Electricity Storage

for

Power and Energy Management

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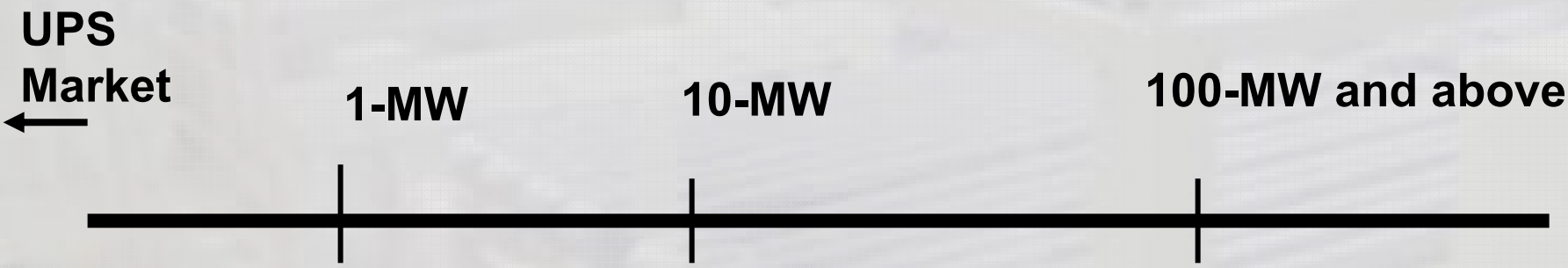
VRB Power Systems
INCORPORATED

Why store Electricity?

- Reduce peak demand and energy costs
- Enhance system stability
- Provide back-up supply of energy
- Reduce emissions
- Increase the usefulness of renewable energy
- Reduce system losses
- Increase the value of abundant, off-peak capacity

$$$$

Storage Technologies



Flywheels
Batteries
- Li Ion
- NiMH

Capacitors

Large-scale batteries
Lead-acid
NAS
VRB
ZBB

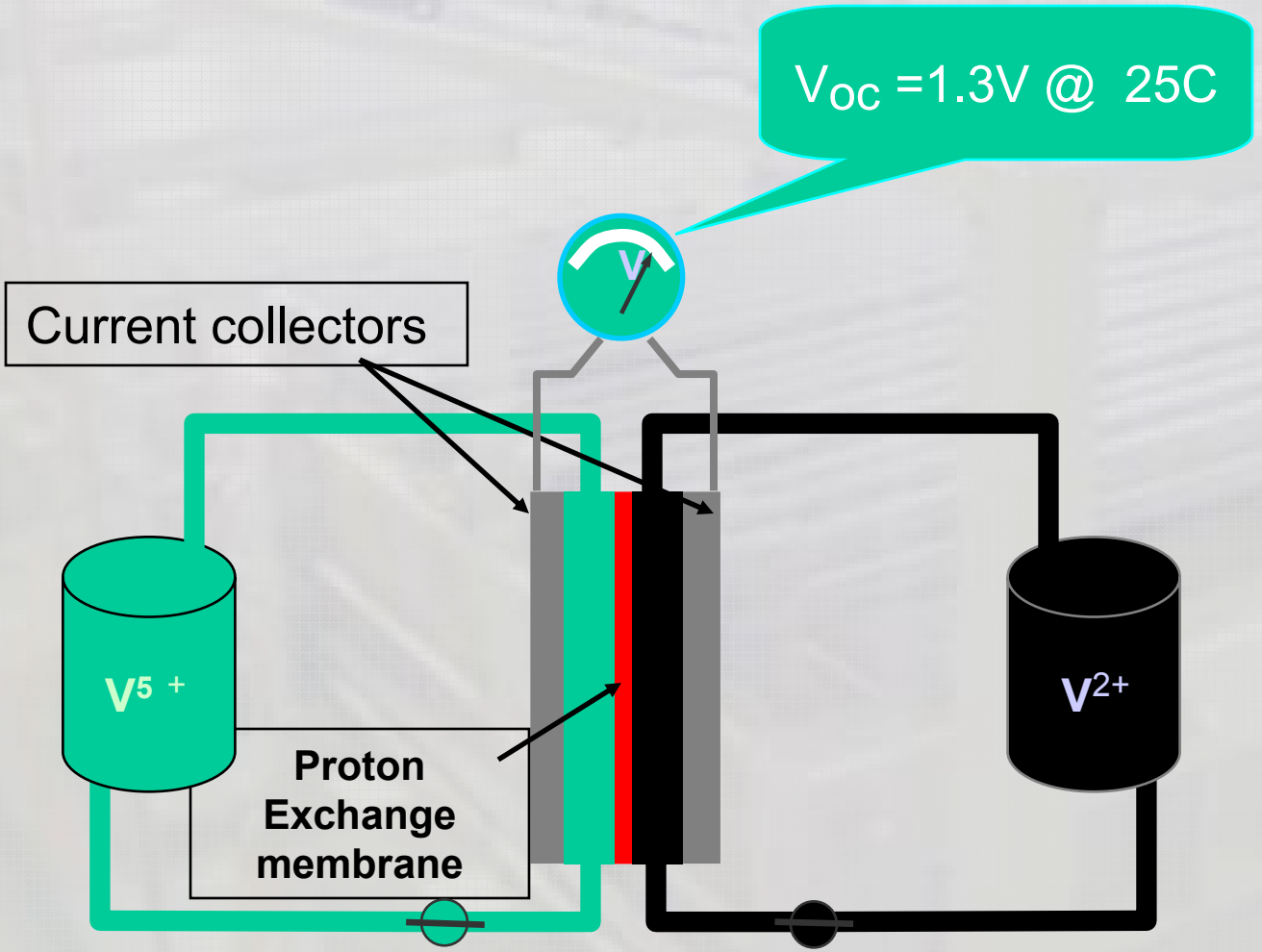
Pumped storage

Compressed Air Energy Storage (CAES)

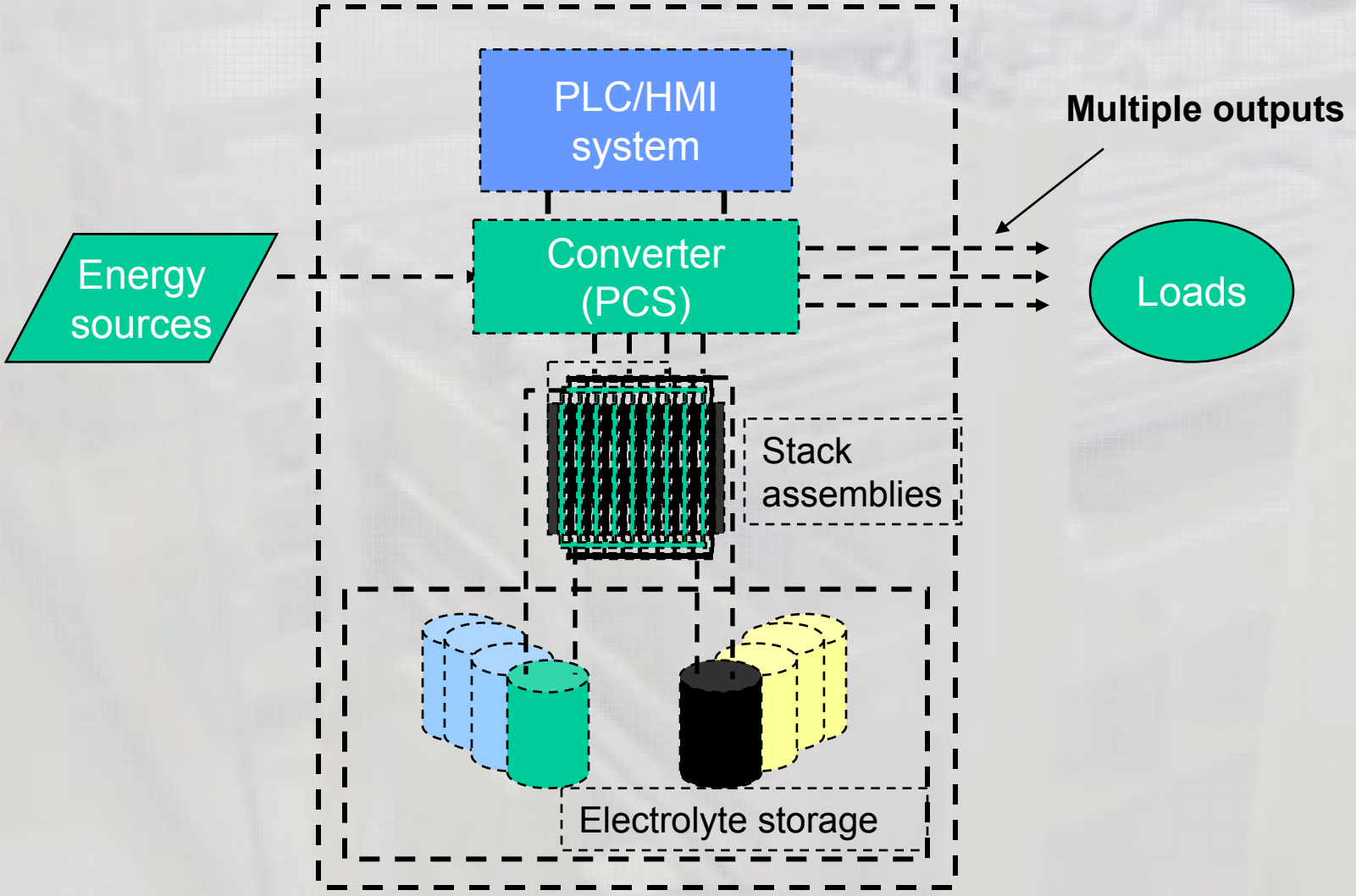
What is a VRB Energy Storage System?

- An electrochemical *energy storage system*
- A flow battery, based on Vanadium
- Based on the reduction and oxidation of different ionic forms of Vanadium
- Energy (electricity) can be stored indefinitely in a liquid – very low self discharge
- Energy can be recovered instantaneously(< 1ms)

VRB-ESS Basics:



VRB-ESS Components




Vanteck


SATCON
Power Systems
DANGER
HIGH VOLTAGE
CAUTION
WARNING
CAUTION: MULTIPLE SOURCES

Technical Advantages of VRB-ESS

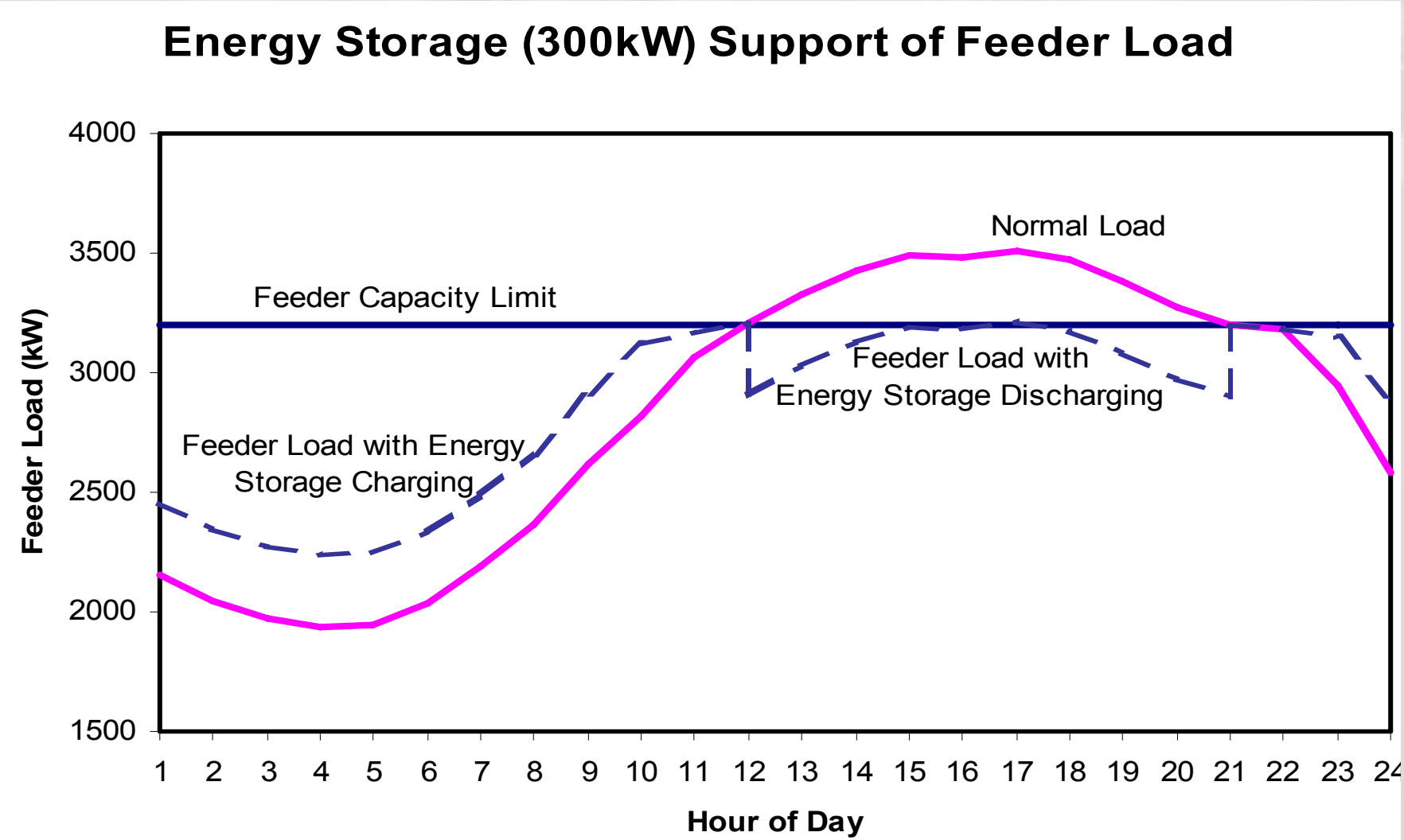
- High-energy efficiencies: 70% round trip.
- Remains fully charged with low self-discharge
- Storage capacity can be easily increased by adding electrolyte.
- Designed for unattended operation with very low maintenance costs ($0.008/kWh).
- Ambient/Low operating temperature.
- Can be discharged and charged >13,000 times without need for membrane replacement.
- Integrated sophisticated multi-quadrant, fast acting PCS provides reactive energy (VARs) continuously.

Environmental Advantages

The Green Battery

- No heavy metals such as lead, nickel, zinc and cadmium
- No air emission; minimal sound emissions
- Electrolytes have indefinite life
  - No disposal issues
  - Completely reusable

Peak Shaving Applications



Lead-Acid Battery Replacement

Cell site applications - 48V

Substation battery replacement

- 10 year life
- Almost no maintenance and no disposal issues
- High efficiency
- Same footprint
- Internal or external cabinet

6 MW VRB-ESS Wind-Coupled Installation at Tomamae Wind Farm, Sapporo, Japan

VRB Power Systems Inc.

Energy Storage & Power Quality Solutions

Conclusion

- The VRB-ESS provides a large-scale energy storage solution that is available today.
- The system can perform multiple functions such as peak shaving while providing UPS.
- The VRB-ESS can increase the value and functionality of wind resources.
- The VRB-ESS can improve the utilization of existing electrical infrastructure while enhancing power quality and reliability.
- The VRB-ESS is an environmentally responsible battery technology.